MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016 / 2017

PPH0135 - ELECTRICITY AND MAGNETISM

(Foundation in Engineering)

19 OCTOBER 2016
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **FIVE** printed pages, excluding the cover page and appendices, with **FOUR** questions.
2. Answer all questions. The distribution of the marks for each question is given.
3. Write all your answers in the answer booklet provided.
4. All necessary workings must be shown.

QUESTION 1 (15 marks)

a) **Figure Q1.1** shows electrons moving in +x direction enter a uniform magnetic field directed into the plane of the page.
(Note: Parts (i), (ii) and (v) in this question must be answered in the same diagram. You are advised to read the questions in parts (i), (ii) and (v) before answering them.)

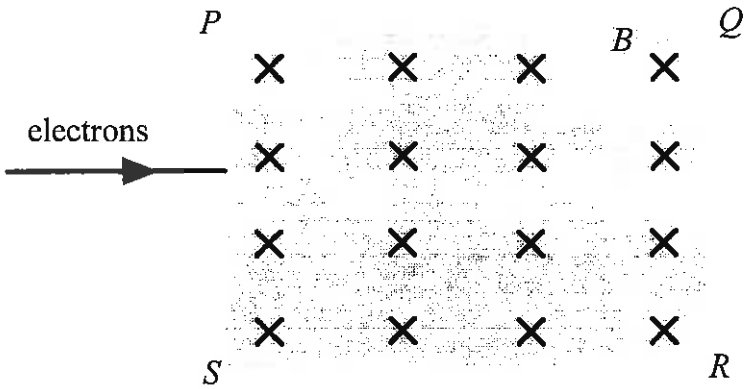

Figure Q1.1

i. Copy the diagram and draw the path taken by the electrons as they pass through the magnetic field region and leave the region from side *QR*. Label the path as **(1).**

(1 mark)

ii. Repeat part (i) for electrons enter the magnetic field with lower velocity. Draw the path taken by the electrons on the same diagram drawn in part (i). Label the path as **(2)**.

(1mark)

iii. Derive the equation used to answer parts (i) and (ii).

(2 marks)

iv. What are the two situations in which an electron in a magnetic field does not experience any magnetic force?

(2 marks)

v. Draw on the same diagram drawn for parts (i) & (ii), the direction of a uniform electric field applied across region *PQRS* so that electrons are not deflected in the region. Label the field as **(3)**.

(1 mark)

b) A rectangular coil (8.0 cm x 5.0 cm), consists of 150 turns, is placed in a uniform magnetic field B = 0.2 T that is directed to the +x direction as shown in **Figure Q1.2(a)**. The plane of the coil makes an angle of 40° to the magnetic field. **Figure Q1.2(b)** represents the loop in **Figure Q1.2(a)** viewed from the +y axis.

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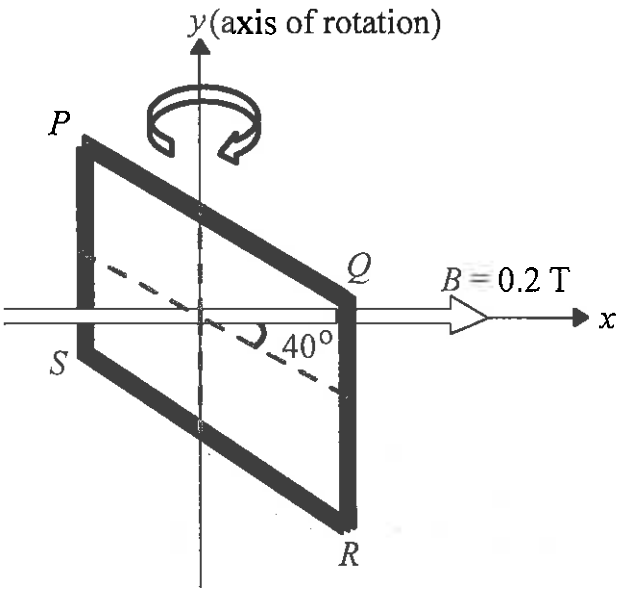

Figure Q1.2(a)

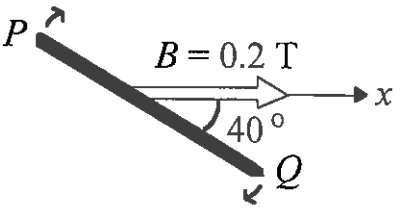

Figure Q1.2(b)

i. Calculate the magnetic flux through the coil.

(2 marks)

ii. The coil is then turned through 50° about the axis of rotation until its plane is perpendicular to the magnetic field in 0.5 s. Calculate the magnitude of the average induced emf in the coil. Determine the direction of the induced current in the coil.

(3 marks)

c) **Figure Q1.3** shows cross sections of two long and straight wire separated by a distance 0.3 m. Wire *2* carries current 2.3 A directed into the page. Determine the magnitude and direction (into or out of the page) of the current in wire *1* if the resultant magnetic field due to the two wires is zero at point *Q* located 1.2 m from wire *2*.

(3 marks)

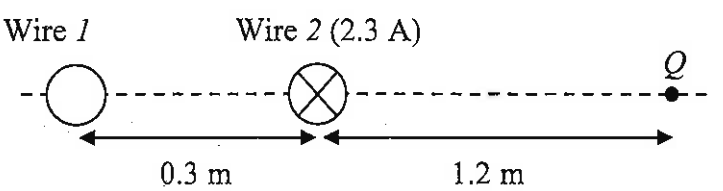

Figure Q1.3

Continued...

QUESTION 2 (15 marks)

a) A battery is connected in series with an ammeter (A) and a variable resistor as shown in **Figure Q2.1(a)**. A voltmeter (V) is connected across the terminal of the battery and the current in the circuit is varied by varying the resistance of the variable resistor. The variation of voltmeter reading V as a function of current I is shown in the graph in **Figure Q2.1(b).**

i. Explain why the voltmeter reading decreases as the current increases?

(2 marks)

ii. Based on the graph in **Figure Q2.1(b),** determine the emf and internal resistance of the battery.

(4 marks)

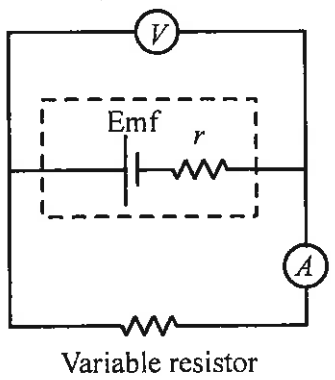

Figure Q2.1(a)

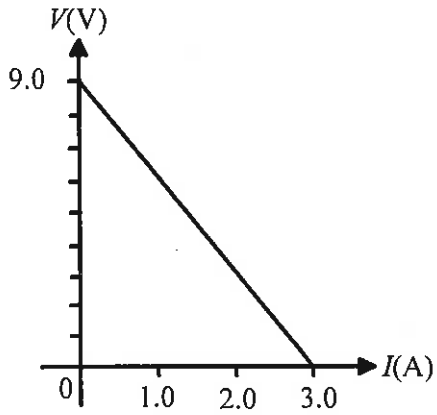

Figure Q2.1(b)

b) Four resistors are connected in a circuit shown in **Figure Q2.2**. If the ammeter (A) reads 0.5 A, what is the voltage of the battery (V)?

(5 marks)

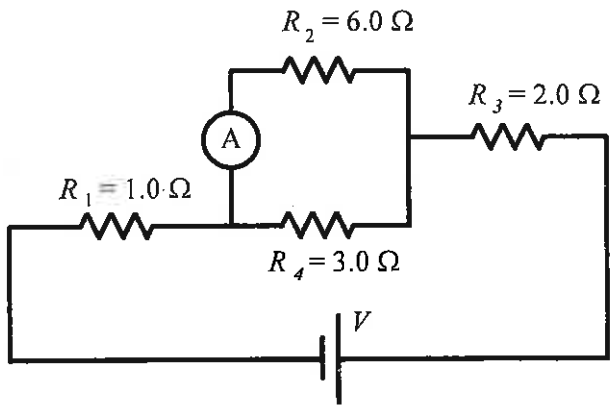

Figure Q2.2

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c) Use Kirchhoff's laws to determine the values of V_1, V_2 and R_4 in the circuit shown in **Figure Q2.3.**

(4 marks)

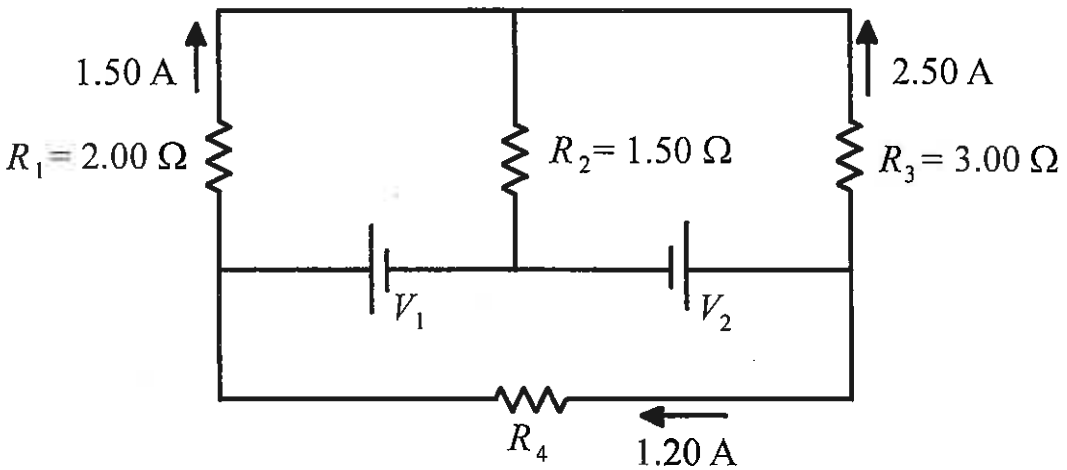

Figure Q2.3.

QUESTION 3 (10 marks)

A series RLC circuit is driven by a generator with an emf amplitude of 120.00 V and a current amplitude of 1.40 A. The current leads the emf by 0.70 rad.

a) Calculate the impedance of the circuit.

(1.5 marks)

b) What is the power factor?

(1.5 marks)

c) Calculate the resistance in the circuit.

(2 marks)

d) Is the circuit in resonance? Explain your answer

(2 marks)

e) Is the circuit largely inductive or largely capacitive?

(1 mark)

f) Determine the average rate of energy delivered by the generator to the circuit.

(2 marks)

Continued...

QUESTION 4 (10 marks)

a) **Figure Q4** shows a circuit containing two silicon diodes, D_1 and D_2. Determine the currents flowing through R_1, R_2 and D_1.

(5 marks)

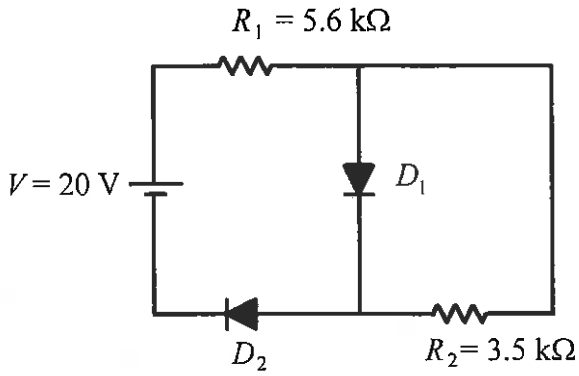

Figure Q4

b) Bipolar junction transistor (*BJT*) is a three-terminal device containing two *PN* junctions formed by sandwiching one type of extrinsic semiconductor material between two layers of another type of extrinsic semiconductor. Based on this physical structure, *BJT* can be divided into two types.

i. Name the two types of *BJT* and draw their symbols. Provide the names of the *BJT* under their respective symbols and label all the three terminals (emitter, base and collector) in each of the symbols.

(3 marks)

ii. Name the two *PN* junctions in a *BJT*.

(1 mark)

iii. What types of bias are applied to the *PN* junctions in part (ii) when *BJT* is under active mode?

(1 mark)

End of Page

APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_0	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_0	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2 /C^2
Permittivity of free space	ε_0/κ_0	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 nI$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L\frac{dI}{dt}$$

$$\xi = -M\frac{dI}{dt}$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x}\right)I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_o N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$P_t = I_{rms}V_{rms}\cos\phi$$

$$P_r = V_{rms}I_{rms}\sin\phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0\left[1+\alpha(T-T_0)\right]$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA\sin\theta$$

$$U = \frac{1}{2}LI^2$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$V_H = Bvd$$

$$V = V_{max}\sin\omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T}\right)V_S$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B.dl = \mu_o I$$

$$d\mathbf{B} = \frac{\mu_O I}{4\pi}\frac{d\ell\times\hat{\mathbf{r}}}{r^2}$$

$$\Phi_B = BA\cos\theta$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$